(12) STANDARD PATENT APPLICATION (11) Application No. AU 2002301288 A1
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Acoustically Resistant Wall

(51)[7] International Patent Classification(s)
E04B 001/84 **E04B 002/00**

(21) Application No: **2002301288** (22) Date of Filing: **2002.10.02**

(43) Publication Date: **2003.02.27**
(43) Publication Journal Date: **2003.02.27**

(62) Divisional of:
90458/98

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ABSTRACT

An acoustically resistant wall especially for use as a dividing wall between rooms or halls such as auditoriums or cinema theatres. The acoustically resistant wall achieves a high sound transmission loss whilst using less materials than known acoustically resistant walls. The present invention is also of a reduced width and is more easily constructed than the acoustically resistant walls of the prior art. The preferred embodiment of the present invention includes a plurality of laterally spaced steel columns, a plurality of vertically spaced, horizontally aligned girts, a plurality of mounts, a plurality of laterally spaced, vertically aligned top hat battens, two surface members, a central cavity and at least one layer of insulating material. The girts are fixedly connected to the spaced steel columns by means of acoustically isolating mounts. The top hat battens are connected to the girts. The surface members, including multiple layers of fire resistant plasterboard, are fixed to the top hat battens.

Figure to be associated with Abstract: Figure 1.

ACOUSTICALLY RESISTANT WALL

BACKGROUND TO THE PRESENT INVENTION:

The present invention relates to acoustically resistant walls, that is to say walls intended to minimise the transmission of sound through the wall, or, in other words walls having a high Sound Transmission Loss ("STL"). Such walls find use as dividing walls between rooms or halls such as auditoriums or cinema theatres. The acoustically resistant wall of the present invention is able to achieve a high STL whilst overcoming a number of the disadvantages of the prior art.

PRIOR ART:

Most prior known acoustically resistant dividing walls consist of a central concrete or steel structure with multiple cladding sheets of plasterboard affixed thereto by acoustically isolating mounts or clips.

An example of such a clip is that produced by Boral Australia Gypsum Limited, as disclosed in AU65859/96 ("the Boral Application"). The Boral Application discloses a lining board mounting system including a clip for a furring channel to which the lining board is secured. The clip includes an externally screw threaded fastener which is engaged with and projects from the clip, an elastomeric sleeve on the fastener, a nut on the fastener to axially compress and thereby radially expand the sleeve in a wall bore, and an elastomeric pad to space and thereby acoustically isolate the clip from the wall when the system is in use.

Prior known acoustically resistant dividing walls have a number of disadvantages including the following:

Firstly, the central concrete or steel supporting structures, which are needed to support the isolated plasterboard cladding sheets, require a large amount of concrete or steel for their

construction. This is disadvantageous due to the cost of materials required to build such walls and the difficult and time consuming nature of their construction.

Secondly, walls of the prior art must be made very wide so that there is sufficient air space between the central supporting structure and the outer panels to minimise the sound resonance which occurs within the wall itself. The width of these walls reduces the available floor space and decreases the profitability of buildings including such walls.
Thirdly, acoustically resistant walls of the prior art require many layers of plasterboard on their outer surfaces in order to attain the required STL levels. Consequently, such walls require an excessive amount of plasterboard for their construction which results in large material and labour costs.

It is therefore an objective of the present invention to provide an acoustically resistant wall which achieves a high sound transmission loss using less concrete and steel, is of a reduced width, and is more easily constructed than the acoustically resistant walls of the prior art.

THE PRESENT INVENTION:

According to one aspect of the present invention there is provided an acoustically resistant wall including a plurality of central, columnar, spaced apart, supporting members, a first set of horizontally aligned, vertically spaced apart girts, each girt of which extends between neighbouring supporting members and each girt of which projects transversely beyond the supporting members in one direction, a second set of horizontally aligned, vertically spaced apart girts, each girt of which extends between neighbouring supporting members and each girt of which projects transversely beyond the supporting members in the opposite direction, a plurality of acoustically isolating mounts affixing each girt of said first set of girts to each of its associated neighbouring supporting members, a first set of vertically aligned, horizontally spaced apart battens secured to the projecting edges of said first set of girts, a second set of vertically aligned, horizontally spaced apart battens secured to the projecting edges of said second set of girts and a cladding layer secured to each of said sets of battens; the girts,

battens and cladding layers being arranged such that the cladding layers define a central cavity.

According to a further aspect of the present invention there is provided an acoustically resistant wall as described above wherein members of the first and second sets of girts are inter-leaved.

According to yet another aspect of the present invention there is disclosed an acoustically resistant wall as described above wherein at least one layer of insulating material is disposed in said cavity

According to an additional aspect of the present invention there is provided a method of constructing an acoustically resistant wall as described above, including the steps of:

(a) fixing the supporting members to a floor;

(b) attaching the first set of girts to the supporting members by the isolating mounts;

(c) attaching the second set of girts to the supporting members;

(d) attaching the first and second sets of battens to the first and second sets of girts respectively; and

(e) attaching a cladding layer to each set of battens.

According to yet another aspect of the present invention there is provided a method of constructing an acoustically resistant wall as described above, including the additional step of securing furring channels to the floor and inserting the bottom ends of the battens into respective furring channels.

According to yet a further aspect of the present invention there is provided a method of constructing an acoustically resistant wall as described above, including the additional step of sealingly connecting the cladding layers and the furring channels to the floor using sealing means.

PREFERRED EMBODIMENT:

One exemplary embodiment of the present invention will now be described with reference to the drawings in which:

Fig. 1 Is a sectional elevational view of an acoustically resistant wall according to the invention;
Fig. 2 Is an exploded sectional elevational view of an acoustically isolating mount, being a component of the wall of figure 1 drawn to a larger scale;
Fig. 3 Is a sectional elevational view of the matter within the enclosure marked 2′ in Figure 1, drawn to a larger scale;
Fig. 4 Is an isometric view of a furring channel, being a component of the matter appearing in figure 3;
Fig. 5 Is a layered skeletal elevational side view of part of the acoustically resistant wall of figure 1;
Fig. 6 Is a sectional plan view of the acoustically resistant wall of figure 1; and
Fig. 7 Is a layered elevational side view of a part of the acoustically resistant wall of figure 1 drawn to a larger scale.

As seen in Figure 1, the acoustically resistant wall (1) comprises two cladding layers (2, 3), a central cavity (4), two sets of horizontally spaced, vertically aligned battens (5) having a top hat section, two sets of vertically spaced, horizontally aligned girts (6, 7, 8, 9), a plurality of isolating mounts (10), at least one layer of insulating material (11), and a plurality of laterally spaced steel columns (12).

Each of the cladding layers (2, 3) may comprise three plies (13, 14 15), each comprising, for example, multiple sheets of fire graded plasterboard, such as 16 mm Fyrechek made by CSR Limited. As seen in Figure 7, the plies (13, 14, 15) are attached to the battens preferably by means of self tapping screws (38). As can be seen in Figure 5, the first ply (15) is screwed to the battens (5) and the second ply (14) is then overlaid on top of the first ply (15). The third ply (13) is then overlaid on top of the second ply (14) so that the joints (16, 17, 18) between plasterboard sheets in each of the plies (15, 14, 13) are staggered, preferably with a minimum of 300 mm between joints (16, 17, 18).

As can be seen in Figure 3, the battens (5) are secured within a furring channel (19) preferably made by Rondo Building Services Pty Ltd ("Rondo"). The furring channel (19) is fixedly attached to a concrete slab (20) by furring channel connective means (not shown) which pass through a layer of high density glass wool (21) positioned between the furring channel (19) and the concrete slab (20). The plies of plasterboard (13, 14, 15), attached to the battens (5), rest upon the concrete slab (20) with sealing means (22) positioned in the join between the plies (13, 14, 15) and the concrete slab (20). Figure 4 shows an isometric view of the furring channel (19).

The horizontally spaced battens (19) are connected to the vertically spaced, horizontally aligned girts (6, 7) preferably by means of self-tapping screws (not shown).

As can be seen in Figure 1, the girts (6, 7) are preferably connected to the steel columns (12) by means of acoustically isolating mounts (10, 24) such as the M107-40 and M104-70 isolating mounts made by Mackay Consolidated Industries ("Mackay"). The vertically spaced, horizontally aligned girts (8, 9) are preferably attached to the steel columns (12) by means of non-acoustically isolating mounts (25, 26). However, if the concrete slab (20) is continuous under the wall, as distinct from two slabs meeting at the wall and separated by an isolating joint, then the non-acoustically isolating mounts (25, 26) should be replaced by acoustically isolating mounts (such as those made by Mackay) in order to achieve the requisite STL levels.

The girts (6, 7), are connected to the steel columns (12) so that one edge of the girts (6, 7) protrudes beyond one side (27) of the steel columns (12) in order that the battens (5) on one side of the wall do not come in contact with the steel columns (12). Similarly, the girts (8, 9) are attached to the steel columns (12) so as to protrude beyond another side (28) of the steel columns (12) so as to prevent contact between the battens (23) on the other side of the wall and the steel columns (12).

As can be seen in Figure 1, the girts (6, 7) and the girts (8, 9) are inter-leaved, that is to say the girts (6, 7) are vertically spaced in an alternating manner in relation to the girts (8, 9). Preferably, the distance between the centres of opposite girts, such as 6 and 8, and such as 7 and 9, is no less than 300 millimetres. This is so that the sonic resonance between the girts (6, 7, 8, 9) within the central cavity (4) is minimised.

The central cavity (4) is fully defined by the cladding layers (2, 3), the concrete slab (20) and a ceiling (29). Preferably, the central cavity (4) is no less than 375 millimetres in width (ie between cladding layers (2 and 3)), so as to minimise the sonic resonance within the wall (1).

As can be seen in Figures 1 and 6, at least one quantity of insulating material (11) is positioned within the central cavity (4) in an upwardly meandering disposition, so as to be positioned between the girt (8) and the battens (5), between the girt (6) and the battens (23), between the girt (9) and the battens (5) and between the girt (7) and the battens (23) etc, so as to minimise the sound transmission from one side of the wall (1) to the other.

As can be seen in Figure 2, the isolating mounts (10, 24) comprise a bolt (31) preferably M16 x 100 millimetres long, a washer (32), an upper mount section (33), preferably being an M107 made by Mackay, a lower mount section (34), preferably being an M104 made by Mackay, a cleat (35), a second washer (36) and a nut (37).

The preferred method of constructing the acoustically resistant wall (1) of the preferred embodiment as described above, includes the steps of:

(a) fixing the steel columns (12) to the concrete slab (20);

(b) attaching the horizontally aligned girts (6,7,8,9) to the steel columns (12) by the mounts (10,24,25,26);

(c) attaching the vertically aligned battens (5) to the horizontally aligned girts(6,7,8,9); and

(d) attaching the cladding layers (2,3) to the vertically aligned battens (5).

The preferred method of constructing the acoustically resistant wall (1) of the preferred embodiment, as described above, may also include the additional step of securing the furring channel (19) to the concrete slab (20) and inserting the bottom ends of the vertically aligned battens (5) into the furring channel (19).

The preferred method of constructing the acoustically resistant wall (1) of the preferred embodiment, as described above, may further include the additional step of sealingly connecting the cladding layers (2,3) and the furring channel (19) to the concrete slab (20) using sealing means.

ACOUSTIC TESTS CARRIED OUT

The acoustically resistant wall (1) of the preferred embodiment, as described above, was subjected to a transmission loss test by the National Acoustic Laboratories ("NAL") in September of 1997. A test sample of the wall (1) was constructed in a testing opening between two reverberation rooms at the NAL acoustic test facility.

The sound transmission class ("STC") of the wall (1) was determined by a program of measurements carried out according to the procedures and methods of Australian Standard

1191-1985, "Acoustics-Method for the laboratory measurement of airborne sound transmission loss of building partitions".

A rating of STC 77 (dB) was measured for the wall (1) test sample.

ACOUSTIC TEST RESULTS:

A complete set of measurements and calculation for the determination of the Sound Transmission Loss of the test wall sample was calculated and is presented numerically and graphically on the spreadsheet annexed hereto and marked with the letter "A". A summary of these results, rounded off to the nearest Decibel as required by AS1191, is as follows:

		Transmission Loss Results	
1/3 Octave Centre Frequency (Hz)	STC77 Wall Criteria (dB)	Test Sample Attenuation (dB)	Difference (dB)
100	-	56	
125	61	58	-3
160	64	64	-
200	67	66	-1
250	70	67	-3
315	73	73	-
400	76	75	-1
500	77	72	-5
630	78	71	-7
800	79	76	-3
1000	80	78	-2
1250	81	81	-
1600	81	87	-
2000	81	88	-
2500	81	89	-
3150	81	89	-
4000	81	88	-
5000	-	82	-

The determination of the STC for a test sample requires a comparison of its sound transmission loss with a series of values for each transmission class rating listed in the STC tables at each 1/3 octave band centre frequency, from 125 Hz to 4,000 Hz. The correct Sound Transmission Class rating determined by these tables is reached when either or both of the following requirements are met:

(a) the test sample transmission loss at any frequency in the range 125 Hz to 4,000 Hz must not lie more that 8 dB below that of the STC graph;

(b) the total sum of the test sample values lying below the STC graph values at the same frequency must not add up to more than 32 dB.

Details of the testing procedure carried out appear below.

TESTING PROCEDURE:

The test sample wall was fitted in an aperture between the reverberation rooms and the aperture perimeter was carefully sealed with a thick sealing compound to avoid acoustical leakage between the two reverberation rooms.

After the "drying" time had elapsed, the sample was performance measured according to the transmission loss methods and procedures of Australian Standard AS 1191-1985, "Acoustics - Method for laboratory measurement of airborne sound transmission loss of building partitions".

The STC value was determined according to procedures specified in AS 1276-1979, ("Methods for determination of sound transmission class and noise isolation class of building partitions").

REVERBERATION ROOMS:

Each acoustical test facility reverberation room is approximately 200 cubic metres in volume and is fully air conditioned by a special temperature and humidity controlled and acoustically attenuated air conditioning system. The floors are pentagonally shaped. The ceilings are inclined to the plane of the floors, and the overall construction ensures that internal opposite facing surfaces are not parallel. Reverberation room construction detail conforms with the sound field diffusivity, volume and shape requirements of International Standardisation Organisation document IS0354 - 1985 "Acoustics, Measurement of sound absorption in a reverberation room".

Both reverberation rooms are inside separate isolating rooms which serve as plenum chambers. This construction ensures freedom from flanking noise transmission problems even when very high acoustical sound pressure levels are generated inside either reverberation room.

A sample testing space of approximately 10 square metres is located within an opening in the common wall between the plenum chambers. This wall is part of the sound shell construction and effectively isolates the sample from any vibrational energy which may be generated inside either reverberation room.

Exposure of either side of any test sample in this test space to a sound field is achieved by apertures in each reverberation room wall which align with the opening in the common wall of the plenum chambers. Acoustical sealing at the location of the openings between the reverberation rooms and the wall holding the test sample is achieved by means of compliant, high transmission-loss gaskets installed between the reverberation rooms and the common wall between the plenum chambers.

The 300 mm thick walls, floor and ceiling of all three rooms and plenum chambers are made from a heavily reinforced, high density concrete which was poured on site during the construction of the Acoustical Test Facility. The reverberation rooms are vibrationally

suspended on damped, high tensile springs resting on neoprene rubber. The entire suspension assembly forms a two-pole resonant suspension system which is tuned below 5Hz.

The complete mounting system of springs, dampers and high compliance acoustical seals around the test apertures ensures negligible vibrational coupling between the reverberation rooms, or interference from outside vibrational sources, for all frequencies within the operating range of the two reverberation rooms. Entry to both reverberation rooms and plenum chambers is by means of bi-parting doors.

Additional sound diffusion within the rooms is achieved by means of non-parallel room surfaces coupled with the careful placing of randomly-oriented, suspended panels (19mm thick plywood sheets) with a total surface area of 40 square metres, which are heavily coated with epoxy resin.

The panels were suspended in accordance with the tuning requirements of International Standardisation Organisations Document ISO 354-1985, "Acoustics-Measurement of sound absorption in a reverberation room".

The room size, geometry, and suspended diffusers in each room ensures that the acoustical performance characteristics fully meet requires of Australian Standard AS1191-1985.

<u>ACOUSTICAL TRANSMISSION LOSS TEST PROCEDURE</u>:

The measurement microphone in each reverberation room was acoustically calibrated and the acoustical noise floor checked in both reverberation rooms. A high level of pink noise was generated in the "send" room and measurements were carried out at twelve positions within each room. During the initial phase of measurement, the high transmission loss coefficients caused problems in obtaining an adequate signal-to-background-noise measurement at some frequencies so a Brûel and Kjaer low noise microphone (Type 4179) was used in the receive

room. This provided sufficient background noise immunity to carry out valid measurements at the respective frequencies.

However, frequencies between 2000Hz and 4000Hz require adjustment because they are less than 10dB but more than 5dB above background as required by AS1191. These were not adjusted because they are not the discriminating frequencies in the determination of this STC value.

This multiple measurement provides a means of calculating the mean and standard deviation of the sound field distribution and establishing a confidence level regarding the accuracy of overall measurement results.

Factors determining sound level measured in the receive room are:

1. sound pressure level in the send room;
2. transmission loss of the sample and;
3. reverberation time of the receive room.

Sets of measurements were obtained at six low height positions and six high positions in both the "receive" and the "send" rooms. Reverberation time in the "receive" room was obtained according to the procedures of AS 1045 ("Acoustics-Measurement of Sound Absorption in a Reverberation Room").

The complete measurement cycle for the test therefore comprised a total of twenty four sets of recordings taken at six combinations of the measurement positions of microphone and loudspeaker. Each set of measurements contained a recording of third octave frequency bands between 100Hz and 5000Hz (eighteen in total). During the measurement procedure, care was taken to check if the measurement to background noise level margin exceeded 10dB before determination of the STC value was made.

Acoustical calibration of each microphone was repeated at completion of the testing cycle to verify accuracy of results.

Although the invention has been described herein with reference to a preferred embodiment including drawings, it will be recognised by persons skilled in the art that numerous variations and modifications may be made to the invention as broadly described herein without departing from the overall spirit and scope of the invention.

The claims defining the invention are as follows:-

1. An acoustically resistant wall including a plurality of central, columnar, spaced apart, supporting members, a first set of horizontally aligned, vertically spaced apart girts, each girt of which extends between neighbouring supporting members and each girt of which projects transversely beyond the supporting members in one direction, a second set of horizontally aligned, vertically spaced apart girts, each girt of which extends between neighbouring supporting members and each girt of which projects transversely beyond the supporting members in the opposite direction, a plurality of acoustically isolating mounts affixing each girt of said first set of girts to each of its associated neighbouring supporting members, a first set of vertically aligned, horizontally spaced apart battens secured to the projecting edges of said first set of girts, a second set of vertically aligned, horizontally spaced apart battens secured to the projecting edges of said second set of girts and a cladding layer secured to each of said sets of battens; the girts, battens and cladding layers being arranged such that the cladding layers define a central cavity.

2. An acoustically resistant wall as claimed in Claim 1, wherein members of said first and second sets of girts are inter-leaved.

3. An acoustically resistant wall as claimed in any preceding claim, wherein said central cavity contains insulating means.

4. An acoustically resistant wall as claimed in any preceding claim, wherein said battens are of top hat section.

5. An acoustically resistant wall as claimed in any one of the preceding Claims, wherein the bottom ends of said battens sit within a furring channel which is secured to a floor.

6. An acoustically resistant wall as claimed in any preceding claim, wherein each said cladding layer includes at least one ply of fire graded plasterboard.

7. An acoustically resistant wall as claimed in Claim 6, wherein each said cladding layer includes a plurality of plies, each of which comprises multiple sheets of 16mm fire graded plasterboard.

8. An acoustically resistant wall as claimed in Claim 7, wherein joints between sheets in adjoining plies are staggered.

9. An acoustically resistant wall as claimed in Claim 8, wherein said joints are staggered by at least 300mm.

10. An acoustically resistant wall as claimed in Claim 5 and any one of Claims 6 to 9 insofar as it depends on claim 5, wherein each said cladding layer and said furring channel are sealingly connected to said floor by sealing means.

11. An acoustically resistant wall as claimed in Claim 10, wherein said sealing means includes at least one layer of high density glasswool.

12. An acoustically resistant wall as claimed in Claim 3 or any one of Claims 4 to 11 insofar as it depends on Claim 3, wherein at least part of said insulating means is positioned between at least one girt of one of said sets of girts and the cladding layer secured to battens secured to the girts of the other of said sets of girts.

13. An acoustically resistant wall as claimed in either Claim 3 or Claim 12, wherein said insulating means includes at least one layer of insulating material.

14. An acoustically resistant wall as claimed in Claim 13, wherein said insulating material is a glasswool building blanket.

15. An acoustically resistant wall as claimed in any one of the preceding Claims, wherein said central cavity is at least 375mm wide so as to minimise the sonic resonance within said wall.

16. An acoustically resistant wall as claimed in any one of Claims 3 to 15, wherein the vertical distance between neighbouring girts is no less than 300mm.

17. An acoustically resistant wall as claimed in any preceding claim, wherein neighbouring battens are approximately 900mm apart.

18. A method of constructing an acoustically resistant wall as claimed in any preceding claim, including the steps of:

(a) fixing said supporting members to said floor;

(b) attaching said first set of girts to said supporting members by said isolating mounts;

(c) attaching said second set of girts to said supporting members;

(d) attaching said first and second sets of battens to the first and second sets of girts respectively; and

(e) attaching a cladding layer to each set of battens.

19. A method of constructing an acoustically resistant wall as claimed in Claim 18, including the additional step of securing furring channels to said floor and inserting the bottom ends of said battens into respective furring channels.

20. A method of constructing an acoustically resistant wall as claimed in either of Claims 18 or 19, including the additional step of sealingly connecting said cladding layers and said furring channels to said floor using sealing means.

21. A method of constructing an acoustically resistant wall as claimed in any one of Claims 18 to 20, including the additional steps of weaving insulating means within said cavity between said girts and said cladding layers.

22. An acoustically resistant wall as claimed in any one of Claims 1 to 17, substantially as hereinbefore described with reference to the drawings.

23. A method of constructing an acoustically resistant wall as claimed in any one of Claims 18 to 21, substantially as hereinbefore described with reference to the drawings.

Dated this 2nd day of October 2002.

CSR LIMITED

by:

HODGKINSON OLD McINNES
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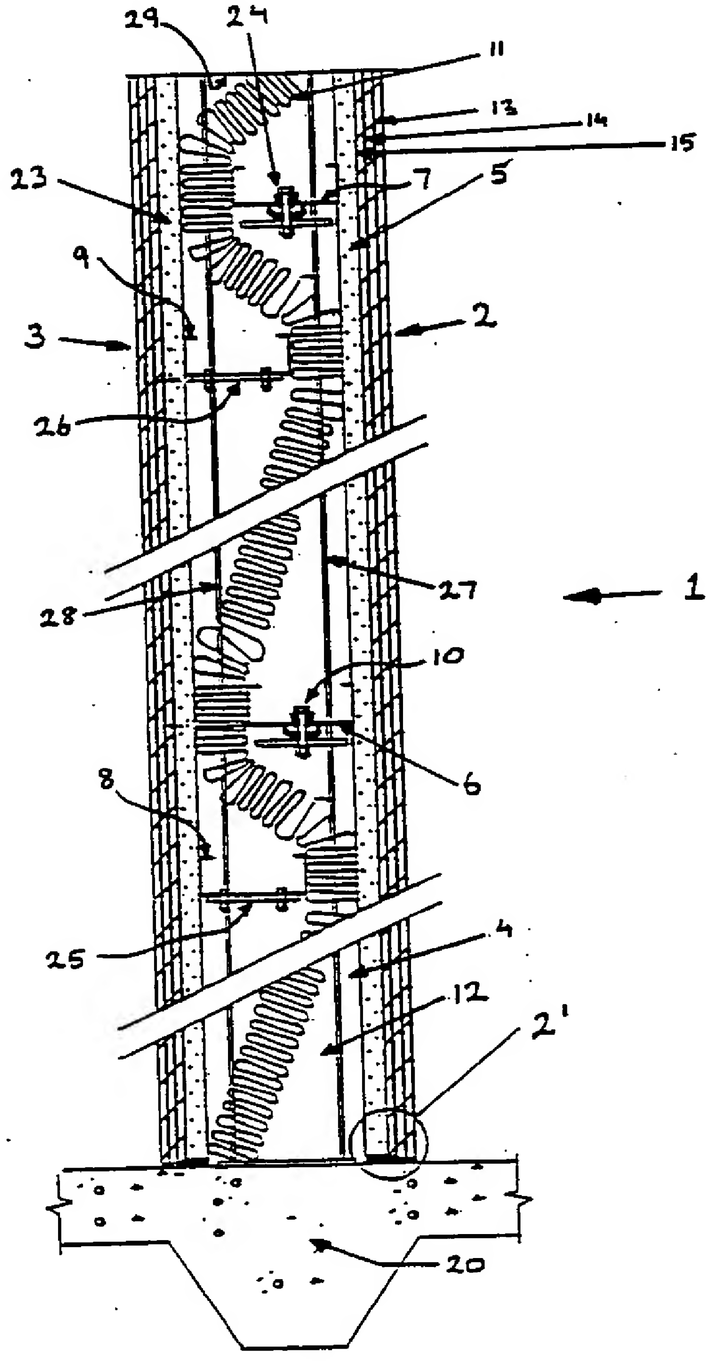

FIGURE 1

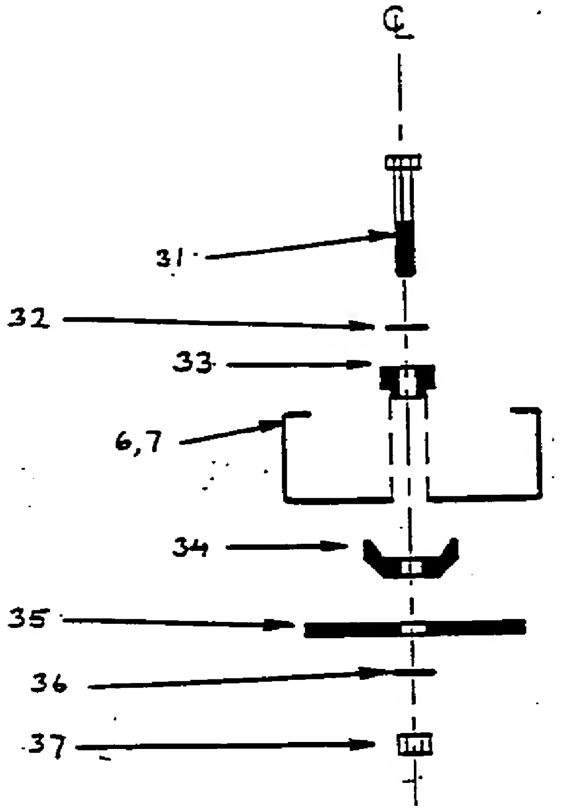

FIGURE 2

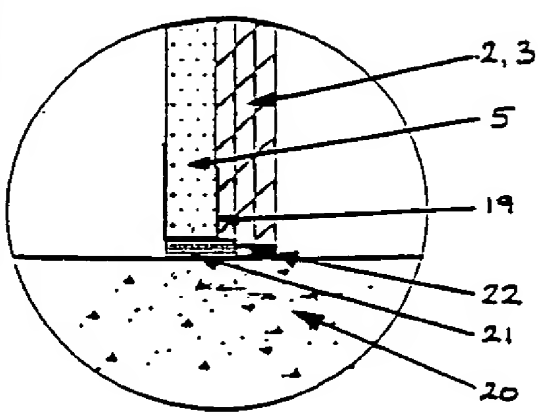

FIGURE 3

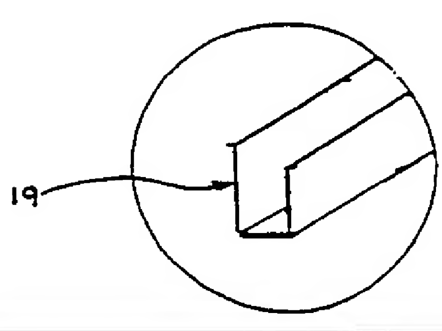

FIGURE 4

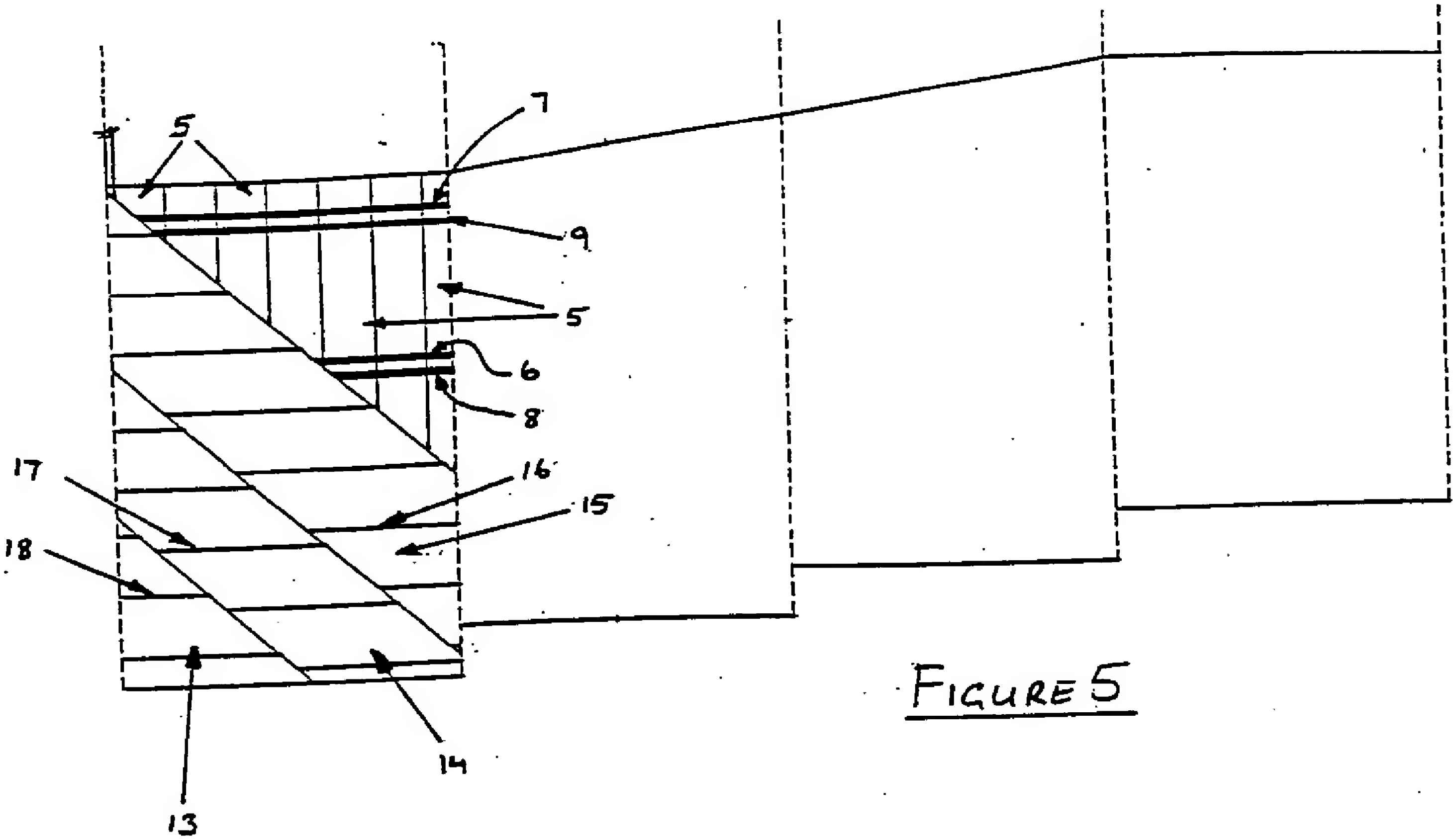

FIGURE 5

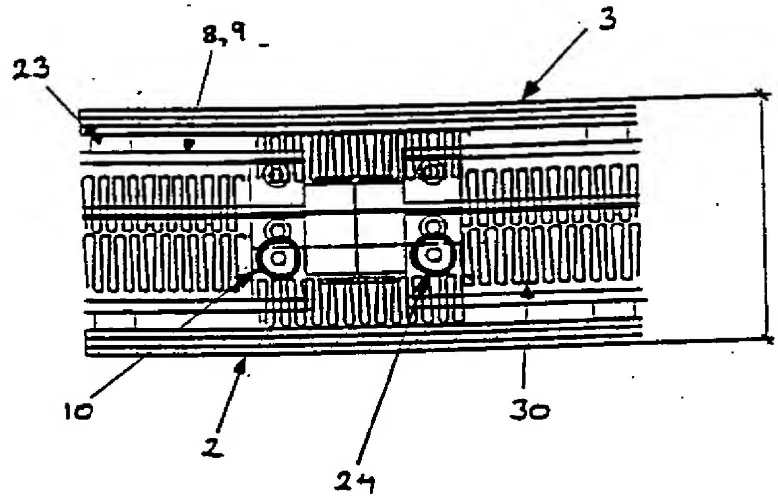

FIGURE 6

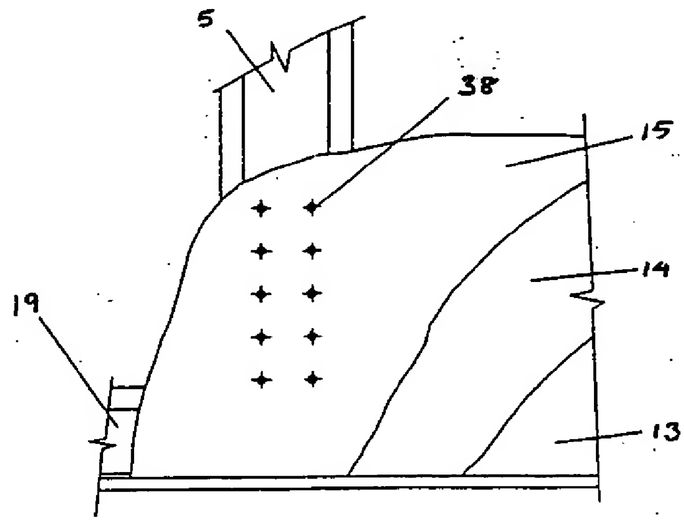

FIGURE 7